APPLICATION NO. 09/826,117

TITLE OF INVENTION: Hybrid Walsh Codes for CDMA

INVENTOR: Urbain A. von der Embse

Clean version of how the CLAIMS will read

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CLAIMS

WHAT IS CLAIMED IS:

Claim **1.** (cancelled)

Claim **2.** (cancelled)

Claim **3.** (cancelled)

Claim **4.** (cancelled)

Claim **5.** (cancelled)

Claim **6.** (cancelled)

Claim **7.** (currently amended) A method for implementation of hybrid Walsh complex orthogonal codes for CDMA, said method comprising the steps of:

forming N Walsh codes each with N chips wherein N is a power of 2,

classifying said Walsh codes into even codes and odd codes according to the Walsh codes even and odd properties,

defining said Walsh codes by {+1, -1} valued orthogonal Hadamard xodes reordered with increasing sequency, wherein

sequency is the average rate of phase changes over each N chip code length,

reordering N discrete Fourier transform codes each with N real chips according to increasing frequency for even and odd codes,

constructing a one-to-one correspondence of said N Walsh codes with said N Discrete Fourier transform (DFT) codes such that sequency corresponds to frequency, even codes correspond to even codes, and odd codes correspond to odd codes,

arranging said DFT codes in increasing frequency, wherein each code is the complex addition of a real axis code and an imaginary axis code,

constructing a mapping which uses said N Fourier codes to construct said DFT codes,

using said mapping and said correspondence of sequency and frequency, and even and odd codes to generate real and imaginary axis component codes of said hybrid Walsh codes,

said hybrid Walsh codes $\tilde{W}(c)$ with code index c=0,1,2,. . .,N-1, are re-orderings of said Walsh codes defined by equations

for $c = 0$, $\tilde{W}(c) = W(0) + jW(0)$

for $c = 1,2,\ldots,N/2-1$, $\tilde{W}(c) = W(2c) + jW(2c-1)$

for $c = N/2$, $\tilde{W}(c) = W(N-1) + jW(N-1))$

for $c = N/2+1,\ldots,N-1$, $\tilde{W}(c) = W(2N-2c-1) + jW(2N-2c)$

wherein $W(u)$ is said Walsh code for index u and $j=\sqrt{-1}$,

generating hybrid Walsh codes by reading code chip values from Walsh code memory and writing to said hybrid Walsh code memory,

reading said hybrid Walsh codes from said Hybrid Walsh code memory and,

using said hybrid Walsh codes in a encoder for a CDMA communications link transmitter by replacing existing said Walsh real codes with said hybrid Walsh complex codes and in a decoder for said communications link receiver, in order to spread the data symbols over the transmission bandwidth.

Claim 8. (currently amended) The method of claim 7 wherein said codes have properties:

code chips take values {1+j, -1+j, -1-j, 1-j} in the complex plane,

code chips with a renormalization and rotation of the code matrix

take values {1, j, -1, -j} in said complex plane,
inphase axis codes of said codes are re-ordered Walsh or Hadamard codes and,
quadrature axis codes of said codes are re-ordered Walsh or Hadamard codes.

Claim 9. (currently amended) The method of claim 7, further comprising the steps of:
using tensor products also called Kronecker products to construct a second code which is a generalized hybrid Walsh code,
whrein an example 24 chip tensor product code is constructed from a 8 chip hybrid Walsh code and a 3 chip discrete Fourier transform DFT code,
said 24 chip tensor product code is defined by a 24 row by 24 column code matrix C_{24} wherein row vectors are code vectors and column elements are code chips,
said 8 chip hybrid Walsh code is defined by a 8 row by 8 column code matrix $\widetilde{W}_8$,
said 3 chip DFT code is defined by a 3 row by 3 column code matrix E_3,
said C_{24} is constructed by tensor product of said $\widetilde{W}_8$ with said E_3 defined by equation

$$C_{24} = \widetilde{W}_8 \otimes E_3$$

wherein symbol "⊗" is a tensor product operation,
row u+1 and column n+1 matrix element $C_{24}(u+1,n+1)$ of said C_{24} is defined by equation

$$C_{24}(u+1,n+1) = \widetilde{W}_8(u_0+1,n_0+1)\ E_3(u_1+1,n_1+1)$$

wherein

$$u = u_1 + 3u_0$$
$$= 0,1,\ldots,23$$
$$n = n_1 + 3n_0$$

$= 0, 1, \ldots, 23$

wherein u,n are code and chip indices for said codes C_{24} and u_0, n_0 are code and chip indices for said code $\tilde{W}_8$ and u_1, n_1 are code and chip indices for said code E_3,

wherein said encoder and said decoder for CDMA communications have memories assigned to C_{24}, $\tilde{W}_8$, E_3 codes,

said C_{24} codes are generated by reading code chip values from said $\tilde{W}_8$ memory and said E_3 memory and combining using said equations to yield said chip values for said C_{24} and stored in said memory C_{24} ,

said C_{24} codes are read from said memory and implemented in said encoder and said decoder,

using direct products to construct a second code which is a generalized hybrid Walsh code,

wherein an example 11 chip direct product code is constructed from said 8 chip hybrid Walsh code and said 3 chip DFT code,

said 11 chip code is defined by the 11 row by 11 column code matrix C_{11},

said C_{11} is constructed by direct product of said $\tilde{W}_8$ with said E_3 defined by equation

$$C_{11} = \tilde{W}_8 \oplus E_3$$

wherein symbol "$\oplus$" is a direct product operation,

row u+1 and column n+1 matrix element $C_{11}(u+1,m+1)$ of said C_{11} is defined by equation

$$\begin{aligned} C_{11}(u+1,n+1) &= \tilde{W}_8(u_0+1,n_0+1) \quad \text{for } u=u_0,\ n=n_0, \\ &= E_3(u_1+1,n_1+1) \quad \text{for } u=8+u_1,\ n=8+n_1, \\ &= 0 \quad \text{otherwise,} \end{aligned}$$

whrein said encoder and said decoder for CDMA communications have memories assigned to said C_{11}, $\tilde{W}_8$, E_3 codes,

said C_{11} codes are generated by reading code chip values from said $\tilde{W}_8$ memory and said E_3 memory and combined using said

equations to yield said chip values for said C_{11} codes and stored in said C_{11} memory,

said C_{11} codes are read from memory and implemented in said encoder and decoder,

using functional combining to construct a second code which is a generalized hybrid Walsh code,

wherein an example 11 chip functional combined $\hat{C}_{11}$ code is constructed from said C_{11} codes by using codes to fill the two null subspaces of said C_{11}.

wherein said $\hat{C}_{11}$ codes are read from memory and implemented in said encoder and said decoder,

using a combinations of tensor products, direct products, and functional combining to construct said generalized hybrid Walsh codes and,

said codes are read from memory and implemented in said encoder for a CDMA communications link and said decoder for said CDMA communications link.

Claim **10**. (cancelled)